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(54) **METHOD AND APPARATUS FOR VEHICLE COUPLING**

(76) Inventors: **Henrik Thorning Christensen**, Tsawwassen (CA); **Jason Elliott**, Richmond (CA); **Bruce Stephen Jenner**, North Vancouver (CA)

Correspondence Address:
DORSEY & WHITNEY LLP
INTELLECTUAL PROPERTY DEPARTMENT
SUITE 3400
1420 FIFTH AVENUE
SEATTLE, WA 98101 (US)

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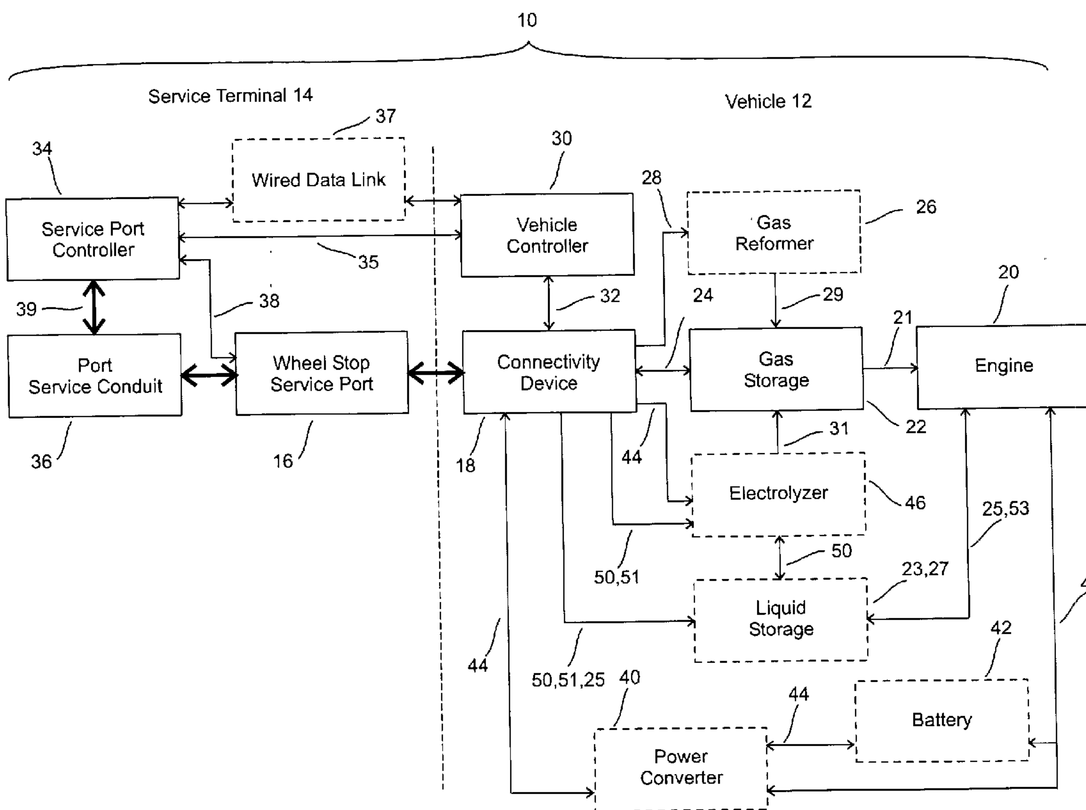
(57) **ABSTRACT**

An energy exchange network provides a coupling service to users of the network. Access to a user through an access controller is controlled initially by allowing only the coupling service to communicate with the user. Several wireless communications zones are established so that the vehicle can be identified and guided to effect coupling. The coupling service effects control of the physical connection of a user vehicle to the energy exchange network. Typically, other services are subsequently provided and a service is not given more access than needed at any point in the sequence, hence a user can only respond to the service currently connected and cannot access other services. The coupling service automates connection to the energy exchange network while protecting the network against unauthorized access. A security service is associated with the coupling service to provide various levels of security for users of the coupling service.



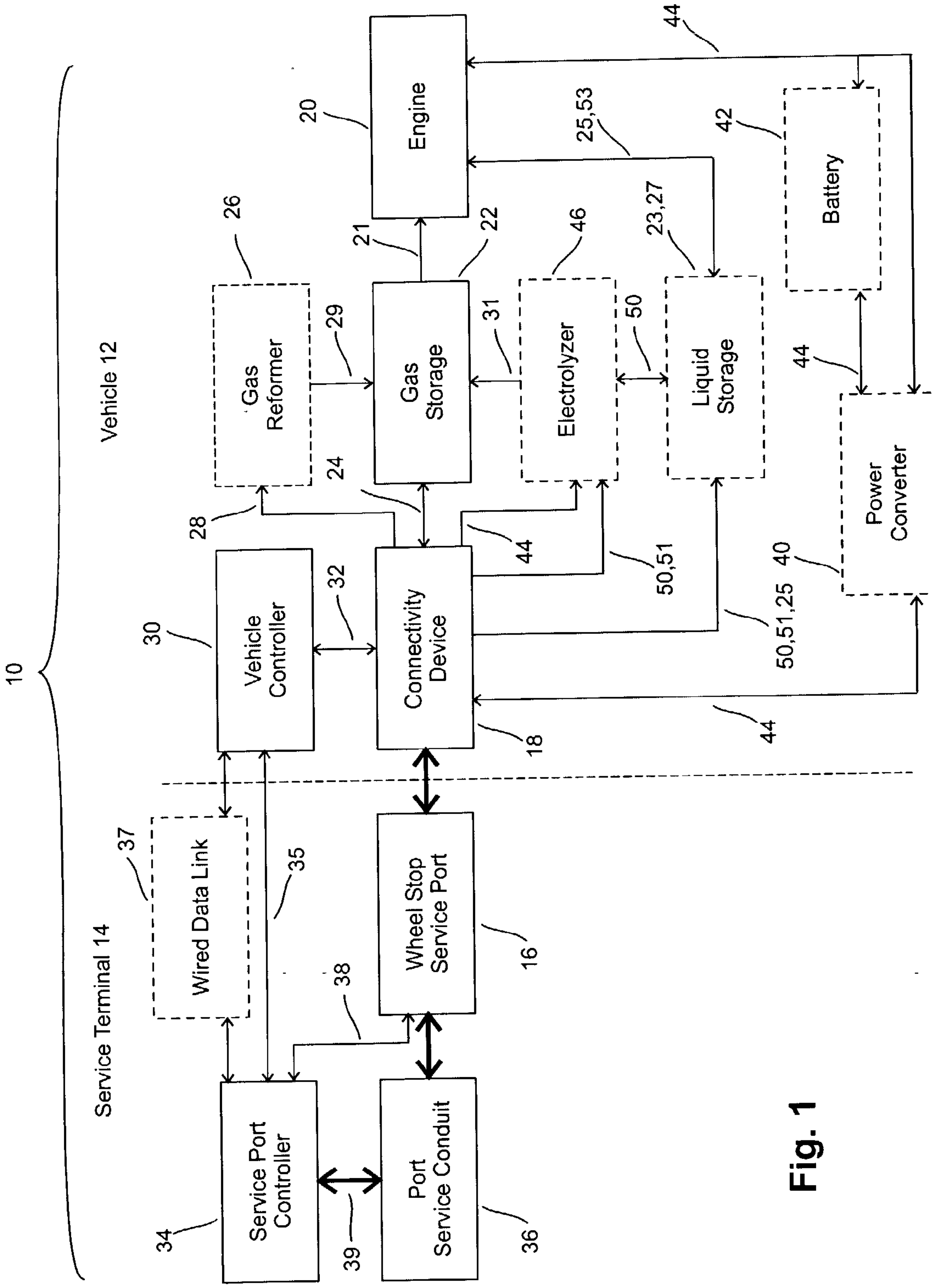
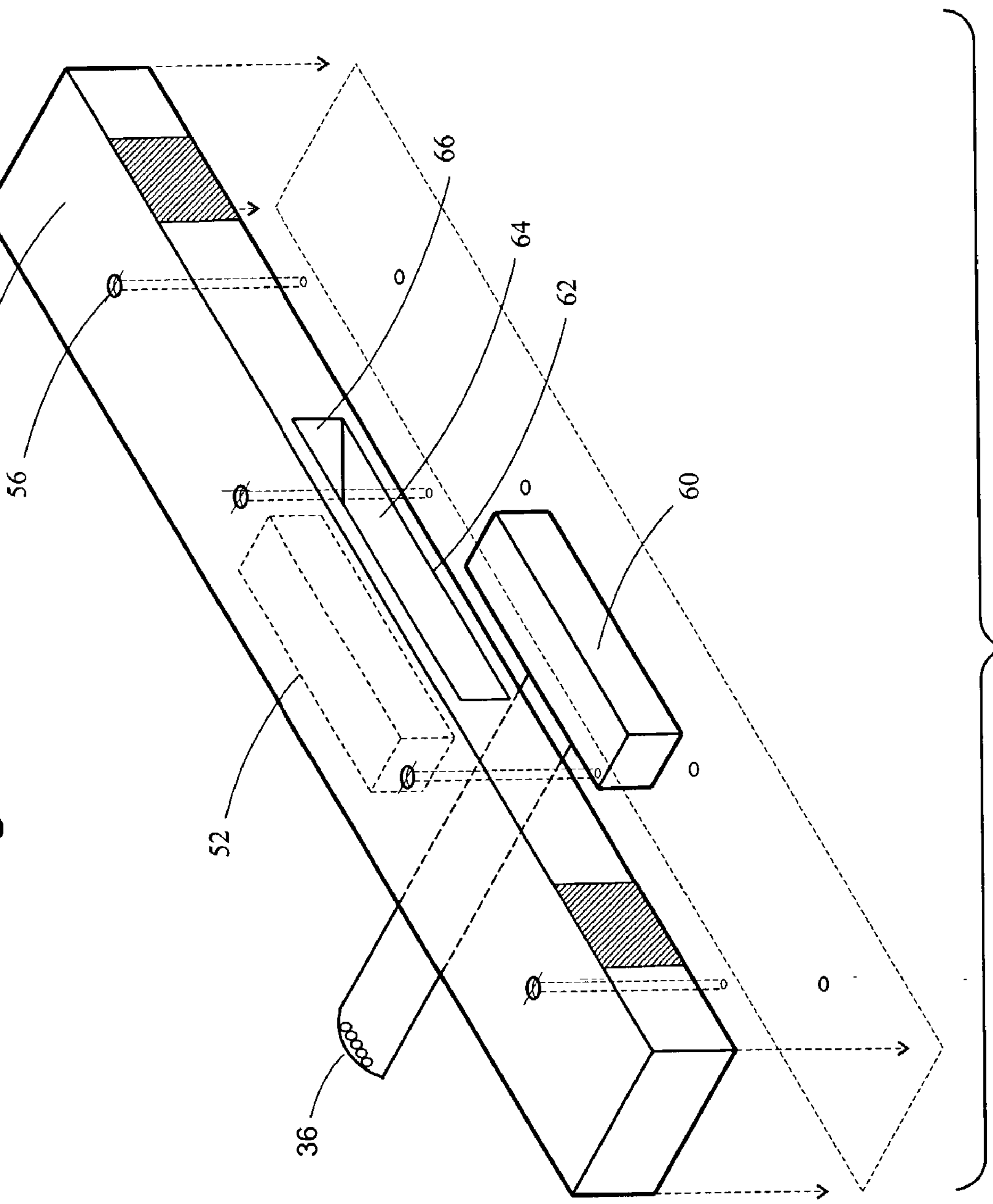

10
Vehicle 12
Service Terminal 14
Engine
20
21
22
Gas Reformer
26
29
Gas Storage
24
28
31
Electrolyzer
46
50
Liquid Storage
23,27
25,53
Battery
42
44
Power Converter
40
Vehicle Controller
30
32
Connectivity Device
18
44
50,51
50,51,25
44
Wired Data Link
37
35
Wheel Stop Service Port
16
38
Service Port Controller
34
39
Port Service Conduit
36

Fig. 1

Fig. 2



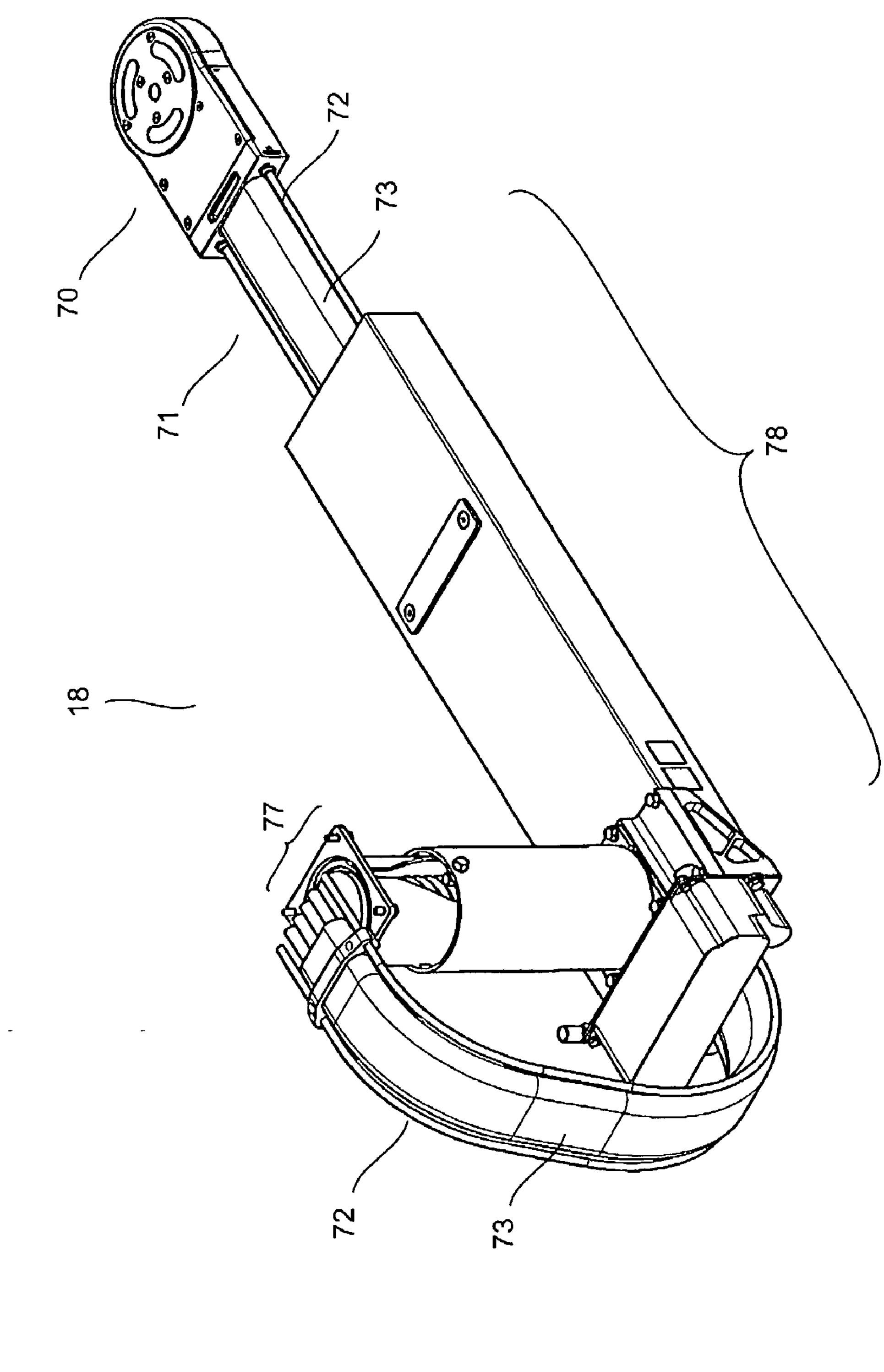


Fig. 3

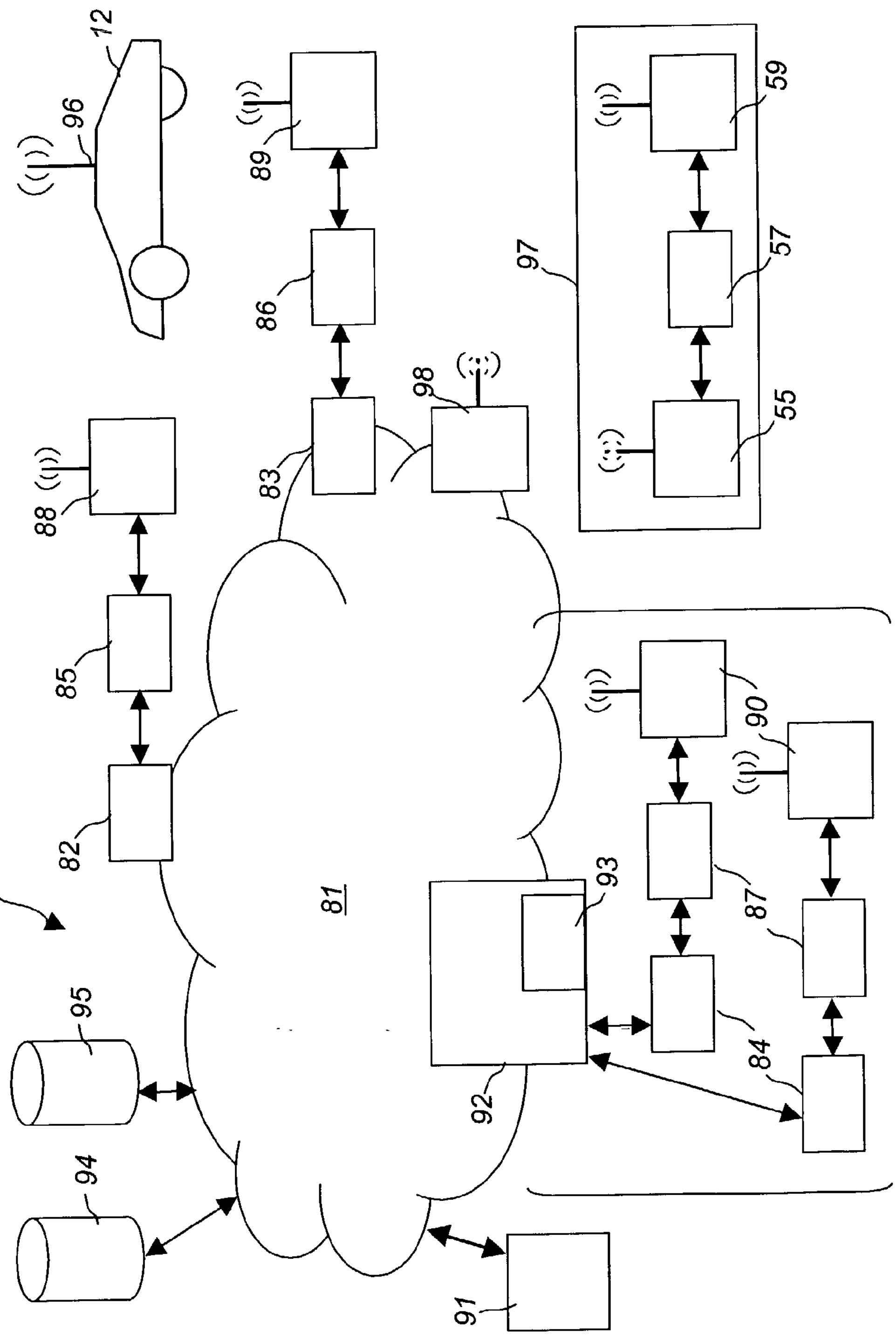
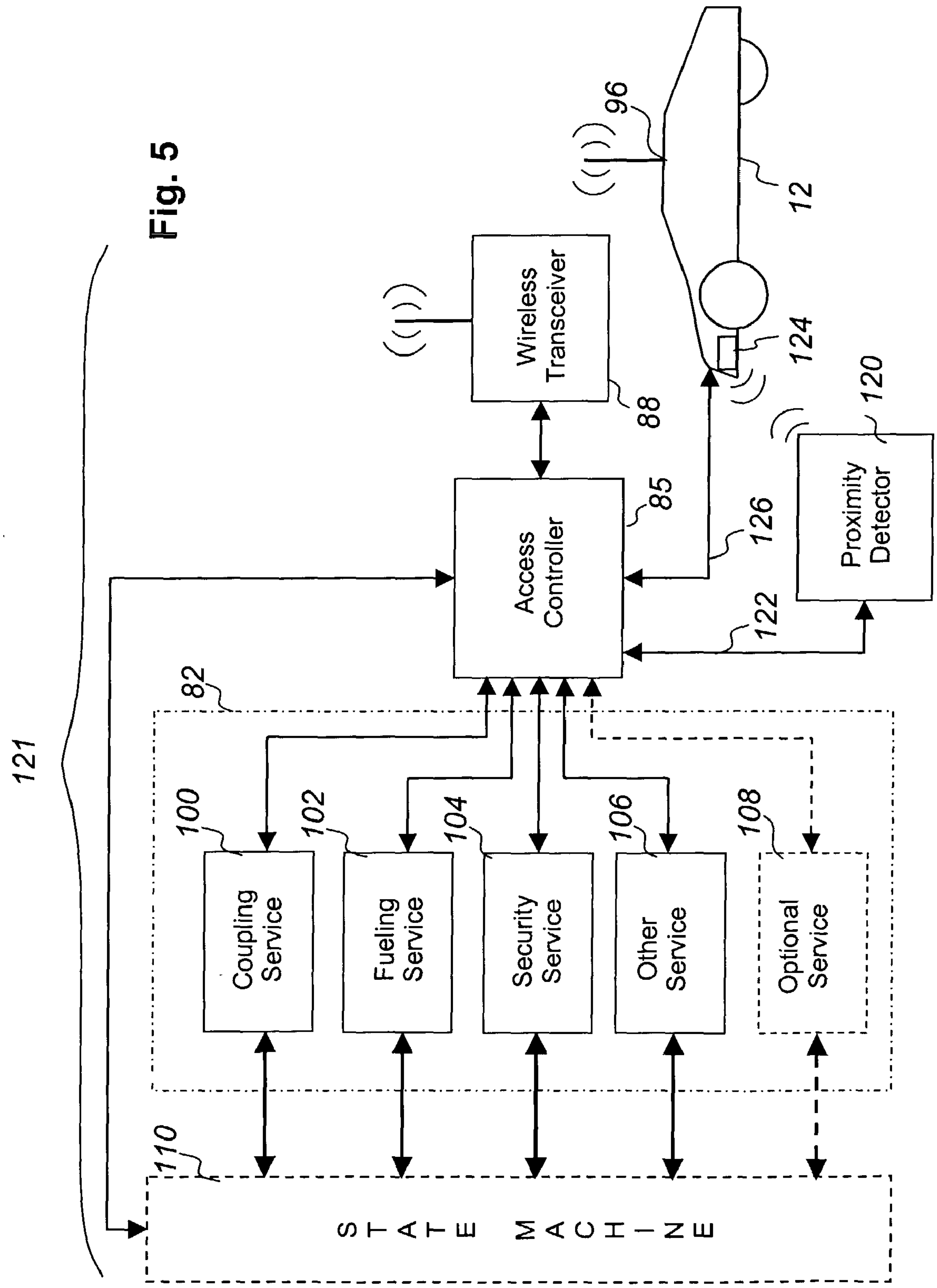


Fig. 4



Wireless Transceiver
88
96
12
124
120
Access Controller
85
126
Proximity Detector
122
82
121
Coupling Service
100
Fueling Service
102
Security Service
104
Other Service
106
Optional Service
108
110
STATE MACHINE

Fig. 5

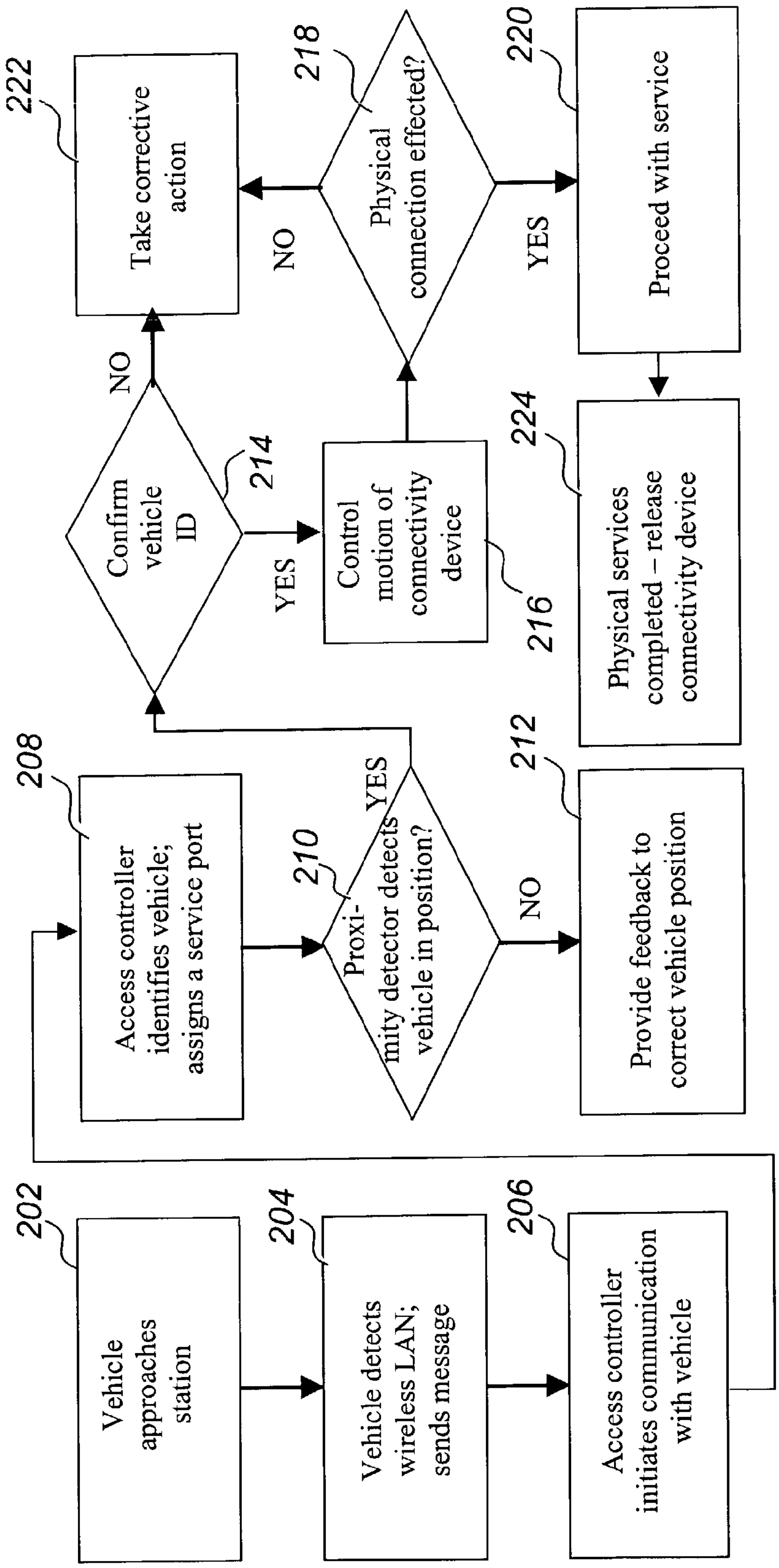

202
Vehicle approaches station
204
Vehicle detects wireless LAN; sends message
206
Access controller initiates communication with vehicle
208
Access controller identifies vehicle; assigns a service port
210
Proxi-mity detector detects vehicle in position?
YES
NO
212
Provide feedback to correct vehicle position
214
Confirm vehicle ID
YES
NO
216
Control motion of connectivity device
218
Physical connection effected?
YES
NO
222
Take corrective action
220
Proceed with service
224
Physical services completed – release connectivity device

Fig. 6

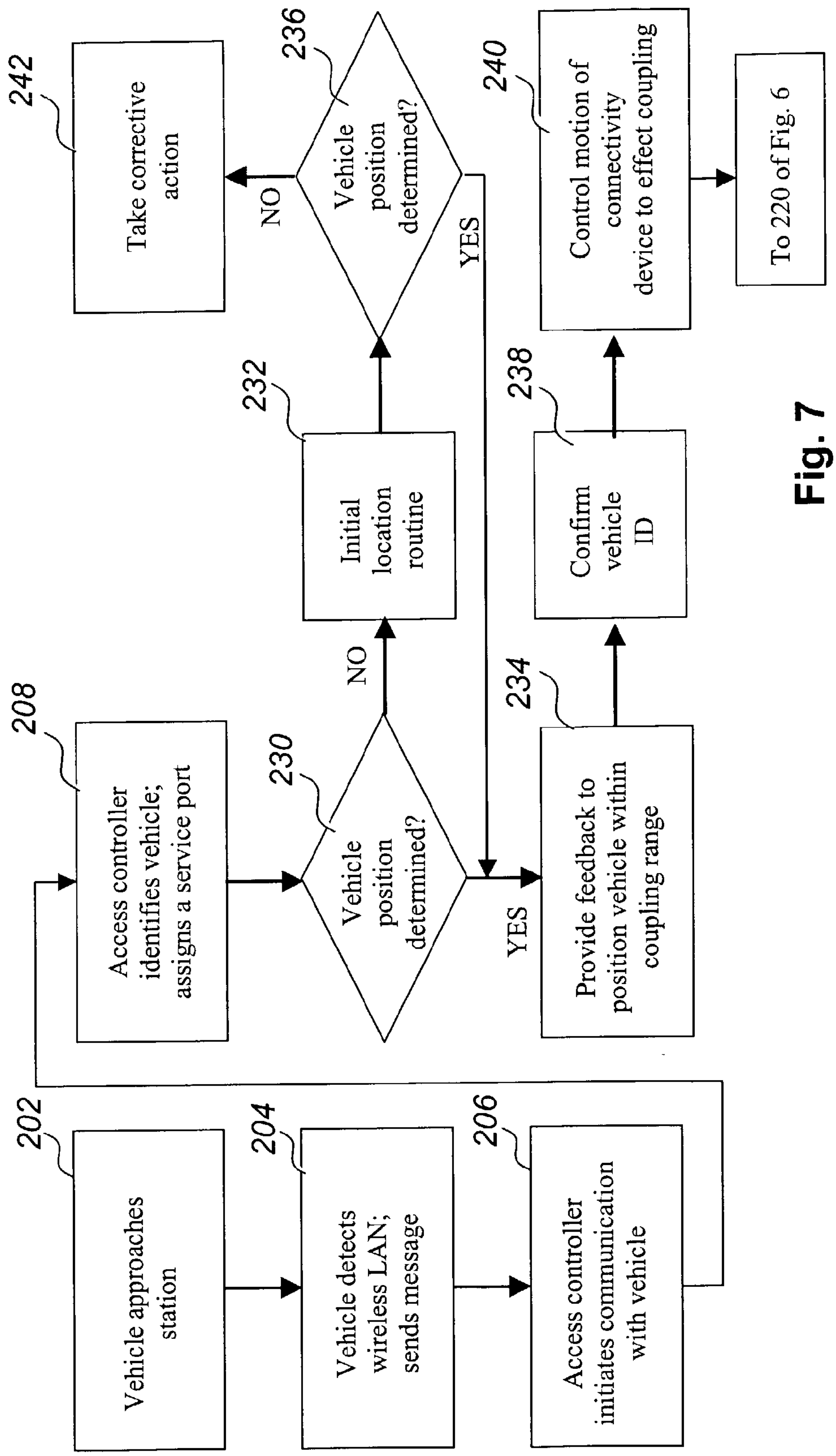

202
Vehicle approaches station
204
Vehicle detects wireless LAN; sends message
206
Access controller initiates communication with vehicle
208
Access controller identifies vehicle; assigns a service port
230
Vehicle position determined?
NO
YES
232
Initial location routine
236
Vehicle position determined?
NO
YES
242
Take corrective action
234
Provide feedback to position vehicle within coupling range
238
Confirm vehicle ID
240
Control motion of connectivity device to effect coupling
To 220 of Fig. 6

Fig. 7

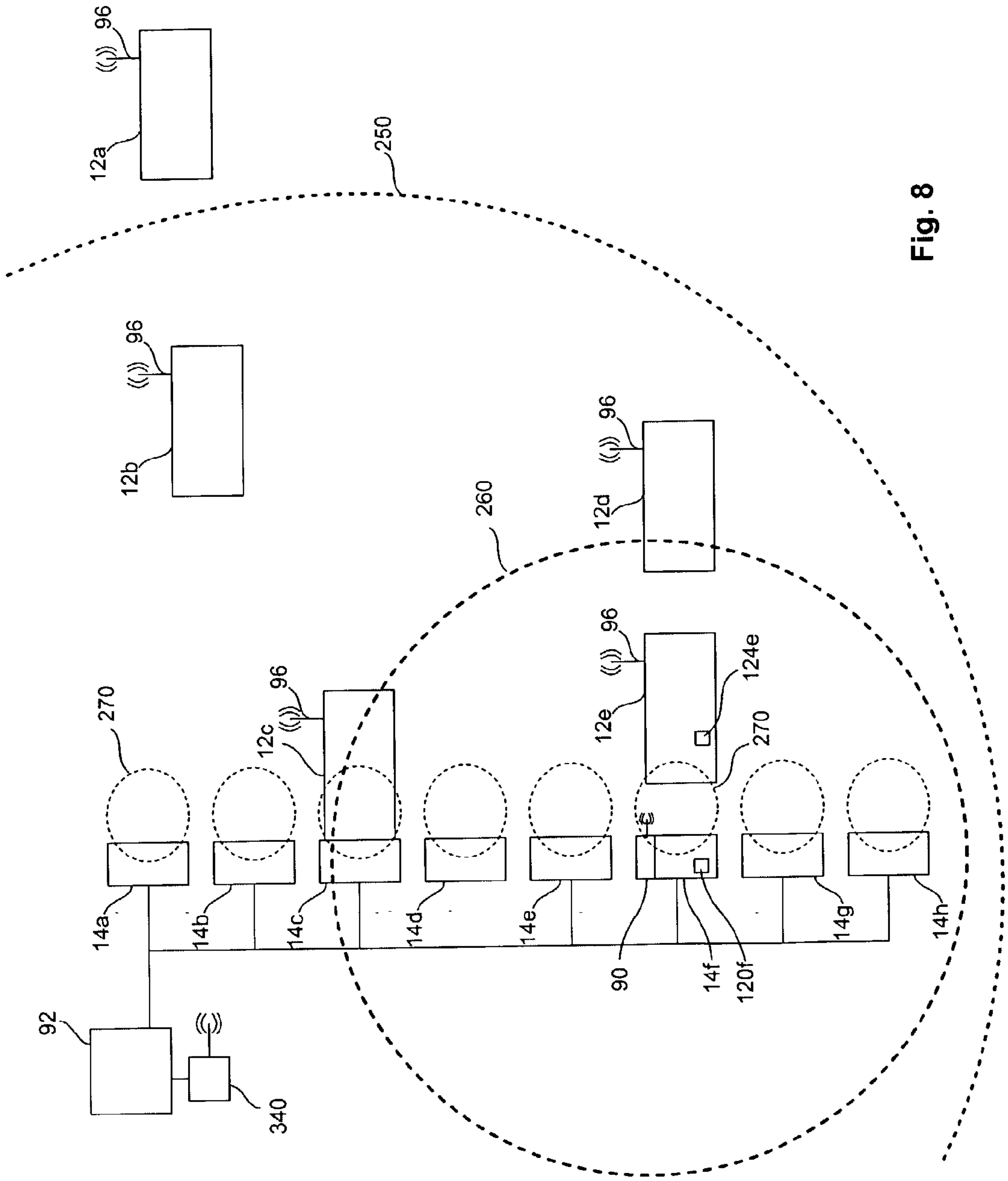

96
12a
250
96
12b
260
96
12d
96
12e
124e
270
96
12c
270
14a
14b
14c
14d
14e
90
14f
120f
14g
14h
92
340

Fig. 8

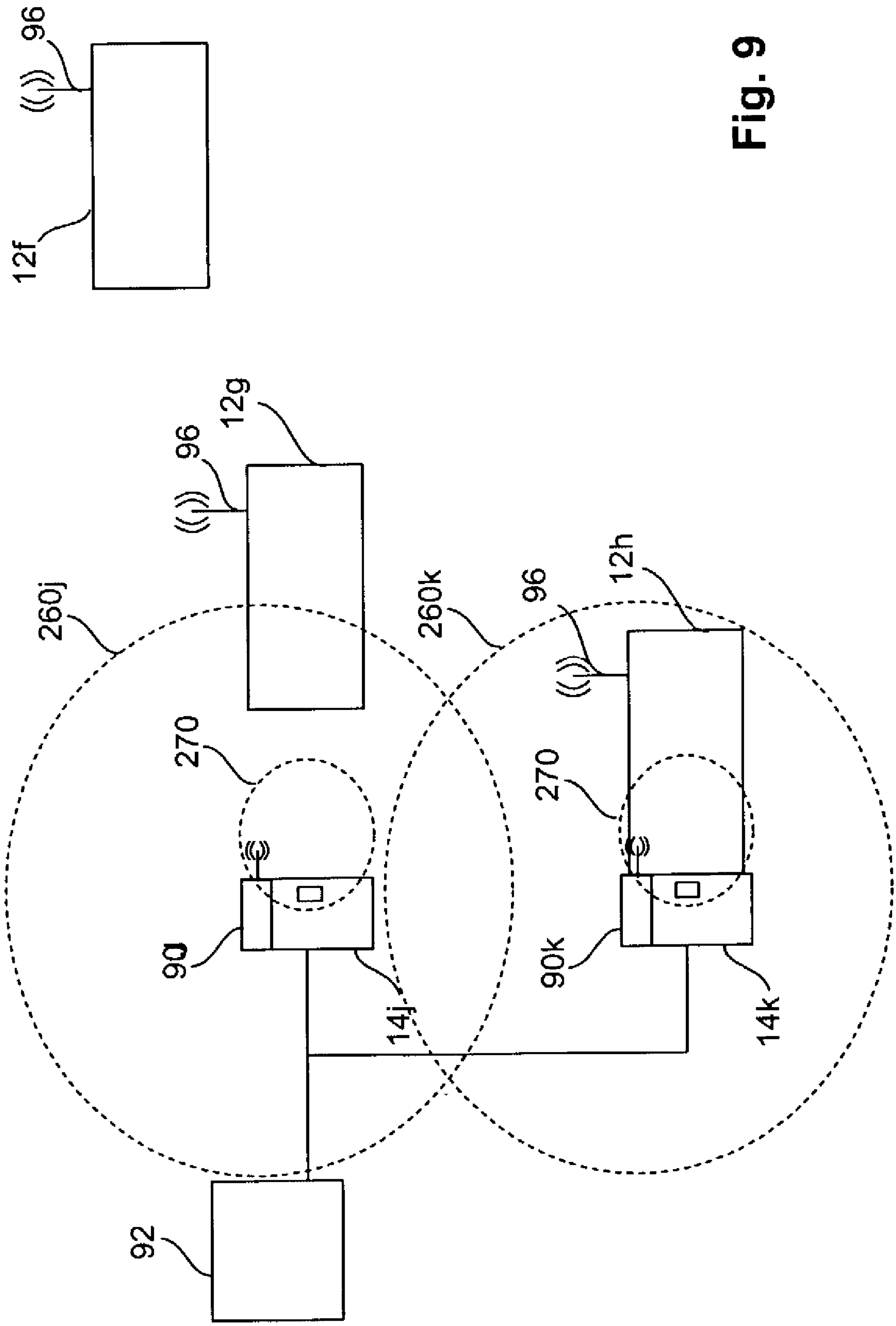


Fig. 9

METHOD AND APPARATUS FOR VEHICLE COUPLING

FIELD OF THE INVENTION

[0001] The present invention relates to vehicle coupling and is particularly concerned with method and apparatus for automated vehicle coupling for energy exchange.

BACKGROUND OF THE INVENTION

[0002] Alternative fuel vehicles have been discussed for a long time. One energy carrier that holds the promise of reducing emissions in urban areas is hydrogen. However using hydrogen as a fuel presents a number of difficult challenges both in vehicle propulsion systems and in the fueling infrastructure.

[0003] One concern with the use of hydrogen as fuel is safety in delivering fuel to vehicles operated by the general public because of a wide range in expertise. The ubiquitous self-serve gasoline stations have accustomed consumers to fueling their own vehicles and have proven economically attractive to station owners. Hence it is unlikely that a return to full service stations would gain wide acceptance.

SUMMARY OF THE INVENTION

[0004] An object of the present invention is to provide an improved method and apparatus for vehicle coupling.

[0005] According to an aspect of the present invention there is provided an apparatus for coupling a vehicle to an energy exchange network comprising: a transceiver for communicating with a vehicle; and a service node controller for controlling communication between the service node controller and a vehicle.

[0006] According to an aspect of the present invention there is provided a method of coupling a vehicle to an energy exchange network the method comprising the steps of: initiating communication with a vehicle; identifying the vehicle from the communication; causing the vehicle to be positioned appropriately for coupling; and effecting physical coupling to the vehicle.

[0007] An advantage of the present invention is providing a vehicle coupling system that enables automated, quasi-automated or manual coupling to a vehicle and authenticates the vehicle, a user of the vehicle or both prior to providing services.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The present invention will be further understood from the following detailed description with reference to the drawings in which:

[0009] **FIG. 1** illustrates in a system block diagram, a service terminal and a terminal-compatible vehicle, wherein liquid and gaseous fuels, water, electricity and data are exchangeable between the terminal and the vehicle;

[0010] **FIG. 2** illustrates in a perspective view, a wheel stop service port of the service terminal in **FIG. 1**;

[0011] **FIG. 3** illustrates in a perspective view, a connectivity device mountable to a vehicle;

[0012] **FIG. 4** illustrates in an energy exchange network including a coupling system.

[0013] **FIG. 5** illustrates a portion of the energy exchange network including a coupling system in accordance with an embodiment of the present invention;

[0014] **FIG. 6** illustrates in a flow chart a coupling method in accordance with an embodiment of the present invention for the coupling system of **FIG. 5**;

[0015] **FIG. 7** illustrates in a flow chart a coupling method in accordance with an embodiment of the present invention for the coupling system of **FIG. 5**;

[0016] **FIG. 8** illustrates in a block diagram a coupling system in accordance with an embodiment of the present invention, implemented in a multi-port station;

[0017] **FIG. 9** illustrates in a block diagram a coupling system in accordance with another embodiment of the present invention, implemented in a two-port service terminal for a residential use.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] An energy exchange system as described includes a service terminal for coupling vehicles to exchange energy services, the terminal including vehicle coupling hardware and connection to energy service provider systems, and an energy exchange network governing the control and management of energy exchange between the connected systems.

[0019] **FIG. 1** illustrates an embodiment of a system **10** for transferring one or more of energy, material or data (collectivity referred to as "services") between system-compatible vehicles **12** and a stationary service terminal **14**. The service terminal **14** may be integrated into a building or pre-existing structure, or be part of a dedicated vehicle service terminal facility or be part of a mobile vehicle service port. In each embodiment, the service terminal **14** has a wheel stop service port **16** and the vehicle **12** has a connectivity device **18** that can couple to the wheel stop service port **16**. Other major components of the service terminal **14** include a service port controller **34** for controlling the transfer of services by the wheel stop service port **16**, and a port service conduit **36** for coupling the service terminal to one or more service destinations (not shown). The destination may be a service source when the service is to be transferred from the source to the vehicle **12**; for example, the service source may be a fuel tank that supplies fuel to the vehicle when coupled to the service terminal **14**. Or, the destination may be a service consumer when the service is to be transferred from the vehicle **12** to the consumer; for example, the service terminal **14** may be connected to a power grid, and the consumer may be an electricity user connected to the grid that receives electricity generated by a fuel cell onboard the vehicle and transferred to the grid when the vehicle is connected to the service terminal.

[0020] The system **10** is particularly suitable for providing services to fuel cell and regenerative fuel cell vehicles, but can also serve vehicles powered by other means, such as natural gas, liquid fuels, electricity, etc. The vehicle **12** has a number of components that make it compatible with the service terminal **14**; the type of components depend on what services are being transferred.

[0021] FIG. 1 illustrates an embodiment of a system 10 that is capable of transferring one or more of gaseous and liquid fuel, water, electrical energy and data between a service terminal 14 and a vehicle 12. The vehicle 12 may include some or all of the components as described in the systems illustrated in FIG. 1. The connectivity device 18 may include one or a combination of the service connections as described below. The wheel stop service port 16 has interfaces for at least gaseous fuel, liquid, electricity and data. The wheel stop service port 16 is suitable to work with the connectivity device 18 of any vehicle, regardless of the maximum number of service connections on the connectivity device 18. An additional function of the system 10 is that the type of connectivity device 18 and the type of service required is determined by communication between the vehicle controller 30 and the service port controller 34. The service port controller 34 provides control signals through the control signal wire 38 to the wheel stop service port 16 directly, or via control signal wire 39 and port service conduit 36 to control the transfer of only those services suitable for the identified connectivity device 18.

[0022] The connectivity device 18 is electrically communicative with a vehicle controller 30 via control signal wire 32, which controls operation of the connectivity device 18; for example, the vehicle controller 30 provides automatic connection and gas transfer control signals to control the transfer of gaseous fuel through the connectivity device 18. The vehicle controller 30 has a transceiver (not shown) to exchange data wirelessly with a transceiver (not shown) in a service port controller 34 of the service terminal 14 (wireless link shown as 35). The construction of the controllers 30, 34 are known in the art. Optionally, a wired data link 37 may be substituted for the transceivers; in such case, data line connection points (not shown) are provided on each of the wheel stop service port 16 and the connectivity device 18 that connect when the wheel stop service port 16 and the connectivity device 18 are coupled or alternatively data can be sent over the electrical power connections. The data communicated to and from the vehicle controller 30 relates to providing data-related services that include vehicle identification, and fueling processes.

[0023] The connectivity device 18 has a gas transfer port (not shown) that is sealably connectable to a gas transfer port (not shown) of the wheel stop service port 16 to enable the transfer of gas between the vehicle 12 and the service terminal 14. The connectivity device 18 is connected to a gas storage cylinder 22 by way of gas line 24. Gas line 24 is bi-directional to enable fuel to be transmitted from the service terminal 14 to the vehicle 12, or vice versa. The gas storage cylinder 22 is fluidly connected to the engine 20 by way of gas transfer line 21. In one embodiment, gaseous fuel is transferred and reformed so that constituents such as hydrogen gas can be stored on-board the vehicle. A gas reformer 26 is provided that is connected to the connectivity device 18 via gas line 28, and connected to the gas storage cylinder 22 via gas line 29, so that gaseous fuel transmitted from the wheel stop service port 16 can be first reformed before being stored in the gas storage cylinder 22 and used by the engine 20.

[0024] An embodiment of the service terminal is to provide the function of electricity transfer to or from the vehicle, for the purposes of powering onboard electrolysis or storage charging, and for transferring generated electricity from the vehicle back through the service terminal. In this case, the connectivity device 18 is configured to transmit electric power between the service terminal 14 and the vehicle 12, and the vehicle controller 30 is configured to control the transmission of electrical energy by the connectivity device 18. Electrical cables 44 electrically couple the connectivity device 18, power converter 40, battery 42, and the engine 20. Similarly, the wheel stop service port 16 is configured to transmit electric power between the service terminal 14 and the vehicle 12, and the service port controller 34 is configured to control the transmission of energy by the wheel stop service port 16.

[0025] A potential use of the service terminal is to transfer liquid fuel such as gasoline. The connectivity device 18 is configured to transfer liquid fuel between the service terminal 14 and the vehicle 12, and the vehicle controller 30 is configured to control the transmission of liquid by the connectivity device 18. Similarly, the wheel stop service port 16 is configured to transmit liquid fuel between the service terminal 14 and the vehicle 12, and the service port controller 34 is configured to control the transmission of liquid fuel by the wheel stop service port 16. A liquid fuel storage tank 23 and liquid fuel lines 25 are designed to store and transmit liquid fuel as known in the art.

[0026] The service terminal, in an embodiment, may transfer water or other liquids to the vehicle for onboard electrolysis for hydrogen generation. A fluid storage tank 27 is provided to store water transferred from the service terminal 14, an electrolyzer 46 is provided to electrolyze the water to produce hydrogen gas, and a gas storage cylinder 22 is provided to store the hydrogen gas for use by the engine 20. Hydrogen fuel lines 21 fluidly connect the gas storage cylinder 22 to the electrolyzer 46 and engine 20 respectively, and fluid supply and return lines 50, 51 fluidly connect the fluid storage tank 27 to the connectivity device 18 and the electrolyzer 46 respectively. Water is supplied to the vehicle 12 as hydrogen feedstock for the electrolyzer 46 via liquid supply line 50, and unused water from the electrolyzer 46 is returned through liquid return line 51. Water line 53 connects the fluid storage tank 27 to the engine 20 to return product water from the engine 20 and to supply water to humidify the gas stream. Both the connectivity device 18 and the wheel stop service port 16 are configured to transfer liquid and electricity between the service terminal 14 and the vehicle 12. Electrical cables 44 electrically connect the connectivity device 18 to the electrolyzer 46. The vehicle controller 30 is configured to control the operation of the connectivity device 18 to transfer water and electricity for the operation of the electrolyzer 46. The electrolyzer 46 is fluidly connected to the gas storage cylinder 22 through gas line 31.

[0027] Referring to FIG. 2, the wheel stop service port 16 serves as a ground-mounted stationary docking location for vehicles 12 equipped with compatible connectivity devices 18. Such vehicles 12 couple to the wheel stop service port 16 and bi-directionally transfer services between the service terminal 14 and the vehicle 12. As mentioned, these services include electrical power, gaseous or liquid fuels, water or data. The wheel stop service port 16 is also designed to prevent the wheels of the vehicle 12 from traveling beyond a specific point in a parking stall and to locate the vehicle 12 in a position that places the vehicle's connectivity device 18 in a position for coupling to the service port 16. Other forms of service ports **16** may be used in the overall energy exchange network, including manual connections from service ports.

[**0028**] The wheel stop service port **16** has a generally elongate rectangular wheel stop housing **58** with fastening holes **56**. The fastening holes receive a fastener (not shown) for fastening the service port **16** to a parking surface. Near the center of the front surface of the housing **58** is a recess opening **62** that opens into a receptacle recess **52**. A connection bay **64** and a receptacle **60** are mounted inside the receptacle recess **52**. The connection bay **64** has a front opening in the shape of a rectangular slot, and has tapered walls **66** that taper inwards both vertically and horizontally into the receptacle **60**. The front opening of the connection bay **64** is flush with the recess opening **62**. The receptacle **60** is mounted inside the receptacle recess **52** behind the connection bay **64** and also has tapered walls (not shown) that taper into the back wall of the receptacle. As discussed in detail below, the tapered walls **66** serve to guide a service plug **70** from the vehicle's connectivity device **18** into a coupling position inside the receptacle **60**, i.e., into a position where the plug contacts the back wall of the receptacle.

[**0029**] In this description, the receptacle **60** and plug **70** are collectively referred to as a "service coupling". Furthermore, the connection bay **64** and receptacle **60** are collectively referred to as the "connection bay assembly".

[**0030**] The tapered walls **66** act to guide, or "self-locate" the plug **70** into a coupling position, thereby removing the need to provide costly electronic coupling guidance systems. It is understood that other self-locating designs such as a funnel may be substituted for the tapered walls **66** as will occur to one skilled in the art.

[**0031**] The service port **16** is externally controlled by the service port controller **34** via a signal conduit housed inside the service conduit **36**. An externally controlled receptacle **60** allows system intelligence such as the service port controller **34** to be located elsewhere, enabling the service port **16** to be economically and easily replaced. Optionally, the service port **16** also has a port status indicator **52** located on the top surface of the housing **58**.

[**0032**] The recess opening **62** is located on the front wall of the service port **16** but it may be located anywhere on the wheel stop housing **58**. For example, the recess opening **62** may open from the top surface of the housing **58** such that the receptacle **60** and connection bay **64** receive a vertically deployed connectivity device **18**.

[**0033**] The receptacle **60** is provided with service exchange interfaces that mate with corresponding service exchange interfaces on the plug **70** to effect a transfer of services therebetween. The service conduit **36** is coupled to the receptacle **60** at the back of the service port **16** and to service sources and/or destinations, thereby enabling the services to be transferred to and from the service port **14** and the service source/destination.

[**0034**] In an alternative embodiment, the service terminal **14** does not include the wheel stop service port **16** and in such case, a service port comprising the connection bay **64** and receptacle **60** are located elsewhere on the service terminal, and the corresponding location of the connectivity device **18** on the vehicle **12** of the alternative embodiment is at a position for coupling to the service port **16**.

[**0035**] Referring to **FIG. 3**, the connectivity device **18** is for connecting the vehicle **12** to the service terminal **14** such that services can be exchanged therebetween. In this first embodiment, the connectivity device **18** is mountable to the front underside of the vehicle **12**, includes a device to deploy the connectivity device from the vehicle, and has plug structures to couple to the receptacle **60** on the wheel stop service port **16** when the vehicle is in close proximity to the wheel stop service port. The major components of the connectivity device **18** are a plug **70** for coupling to the receptacle **60** of the service terminal **14**, a compliant member **71** attached at one end to the plug, a deployment apparatus **78** attached to the compliant member for deploying the plug from a stored position into a deployed position and retracting same back into the stored position, and a vehicle mounting assembly **77** attached to the deployment apparatus **78** and mountable to the underside of the vehicle **12**.

[**0036**] The compliant member **71** comprises a pair of flexible water lines **72** and flexible electrical cables **73** having a plurality of flexible electrical power conductors (not shown) housed within a protective jacket. The water lines **72** and the power conductors are coupled to components of the vehicle **12** that use or supply water and/or electricity. For example, the water lines **72** and electrical cables **73** may be connected to the on-board electrolyzer **46** to supply feedstock water and power the electrolyzer **46**, respectively. Another option is that a hydrogen supply line is provided (not shown) for the purpose of direct fueling of the vehicle from a stored source of hydrogen.

[**0037**] In operation, the service coupling is engaged whenever the vehicle parks at a service port **16**. The vehicle is typically parked at a service port **16** for fueling although it may also be parked to enable the transfer of information from or to the service port controller **34** and a network controller (not shown in the figures). The plug **70** of connectivity device **18** is inserted into the receptacle **60** and is physically clamped in place by the clamp actuator (not shown) in the wheel stop service port **16**. Typically the wheel stop service port **16** is fixed to the ground or parking structure and receives power from a fixed line. Thus the wheel stop service port **16** is able to physically fix the vehicle **12** in place independent of the vehicle power supply or vehicle engine systems. The docking process allows only an authorized user to unlock the docking mechanism. User authorization may be determined using a variety of techniques, such as: user ID and password; card and personal identification number (PIN); or biometric scan.

[**0038**] An alternative embodiment of the invention mounts the connectivity device **18** to a different part of the vehicle **12**, or mounts the receptacle **60** to a different part of the service terminal **14**. A further alternative embodiment locates the connectivity device **18** on the wheel stop service port **16**, and locates the receptacle **60** on the vehicle **12**; in such case, the connectivity device extends from the wheel stop service port to couple to the vehicle when the vehicle is in close proximity to the wheel stop service port.

[**0039**] In one form of the invention the wheel stop service port **16** is installed at the vehicle owner's residence such that the vehicle can be fueled overnight or can generate power while parked at a private residence.

[**0040**] Referring to **FIG. 4**, there is illustrated an energy exchange network **80** including a coupling system in accordance with an embodiment of the present invention. The coupling systems are located at network nodes corresponding to service terminals **14** that include service port subsystems for communicating and coupling to vehicles **12** accessible to the network. An energy exchange station node controller **92** is located at energy exchange stations (not shown). An energy exchange station controls and manages multiple service ports **16** and coordinates network communications with individual service node controllers **82, 83, 84** at the service port. The station node controller **92** controls access to energy services and are connected to a plurality of service terminals **14** and enable management of local energy and services by the service terminals at that energy exchange station. An energy exchange network **80** includes a plurality of energy exchange network servers **91**, a plurality of service node controllers **82, 83, 84**, each coupled to an energy exchange network server via the wide area network **81**. The wide area network **81** may include combinations of a private or public network, and technologies such as wireless, dialup, wired, satellite, broadband or internet systems. Service node controllers **82, 83** and **84** are coupled to access controllers **85, 86, 87**, which in turn are coupled via node transceivers **88, 89, 90** to vehicles **12** provided with a corresponding communications transponder **96** or transponders **96**. The access controllers **85, 86, 87** restrict services of their respective service node controllers **82, 83, 84** according to authorizations associated with potential users, such as a user corresponding to node transponder **96**.

[**0041**] Each node transceiver **88, 89, 90** establishes a wireless local area network (LAN). Each node may be serviced by a single wireless LAN as illustrated in **FIG. 4**, or may have multiple wireless transceivers establishing multiple wireless LANs.

[**0042**] The energy exchange station node controller **92** is communicable with the service node controllers **84** associated with service terminals **14** located at the energy exchange station (not shown) and may control services provided through the associated service terminals, as well as local energy storage and distribution. In this example, the station node controller **92** communicates directly with the wide area network **81**, and the service node controllers **82, 83, 84** communicate requests to the network through the station node controller. The station node controller **92** or individual service node controllers **82, 83, 84** may have a local cache **93** for storing authorization data and profiles, to enable services even when there is no connection to the network **81**. The local cache **93** may include a database.

[**0043**] In either case, access to service node controllers **82, 83, 84** or via the wireless LAN is restricted by access controllers **85, 86, 87**. Once the user corresponding to transponder **96** has docked the vehicle **12**, a physical connection can optionally be established to support a data link between the access controller **85, 86, 87** and the transponder, consequently at least some of the ports can be accessed through a wired port in the vehicle coupling.

[**0044**] The energy exchange network server **91** provides energy services and management of distributed energy exchange transactions, manages transactions with energy service providers **94** and **95** (ESP) including buy and sell orders, and manages the energy exchange network **80** and service node controllers **82, 83, 84**. Typically, a plurality of energy exchange network servers **91** is connected to the wide area network **81** to maintain a large scale of users and transactions. Data related to energy service providers **94** and **95** may be accessed via the energy exchange network **80** and the wide area network **81** and used to control buying and selling energy between the networked subsystems of the energy exchange network. An energy exchange network server **91** may include access to databases (not shown) for vehicle and user authentication and transaction data.

[**0045**] Users of the energy exchange network **80** may access the network through any of the energy exchange nodes or energy exchange network connections and may include ESP's, service providers, owners of service ports, vehicle owners and network managers.

[**0046**] In another embodiment, a mobile service node controller **55**, similar in function to the above described stationary energy exchange service nodes, may be located in a mobile service port **97** to provide networked energy services. The function of the mobile service port **97** is to provide energy exchange, roadside support, fleet fueling, defueling, and emergency services to vehicles or other devices that require such services distant from a stationary energy exchange service system. In this embodiment, the wide area network **81** includes a second wireless network for mobile communications **98**, which communicates wirelessly with the mobile service port **97** by way of a wireless connection with a mobile service node controller **55**. The wireless connection between the network for mobile communications **98** and the mobile service node controller **55** is effected by commonly available mobile communications including cellular or satellite networks. The mobile service node controller **55** is in turn coupled to a mobile access controller **57**, which in turn is coupled via mobile node transceiver **59** to vehicles **12** provided with corresponding communications transponder **96** or transponders **96**. The mobile service port **97** includes an automated service port **16** that is automated, and optionally a service port with manual connection.

[**0047**] Referring to **FIG. 5**, there is illustrated a coupling control system **121** for the energy exchange network **80** of **FIG. 4**. The coupling control system **121** includes a service node controller **82**, an access controller **85**, and a node transceiver **88**. The service node controller **82** includes a plurality of services **100, 102, 104, 106** and **108**. The access controller **85** is coupled to the node transceiver **88** for communications with a user vehicle **12**. The coupling control system **121** also includes a state machine **110** coupled to the service node controller **82** and the access controller **85**. The state machine is instantiated by the energy exchange network **80** and may be resident in any appropriate processor, however, for the present example a local instantiation is considered. A proximity detector **120** is also coupled to the access controller **85** via a link **122** for detecting a proximate vehicle **12** via its proximity transponder **124**. Once coupled, the vehicle **12** can establish an additional data link **126** to the access controller **85**.

[**0048**] In operation, as a user vehicle **12** enters communication range of node receiver **88**, the user vehicle's communication transponder **96** alerts the node transceiver **88**. The node transceiver **88** communicates with the access controller **85**. The initial information communicated is an identification of the user vehicle **12**. The access controller **85** effects the change in the state machine **110**, allowing the coupling service **100** to initiate communications with the user vehicle **12**. Each of the services controlled by the service node controller may only be initiated by the state machine **110** and are not responsive to direct commands from the user vehicle **12**. Hence, the role of the access controller **85** is to mediate between the service node controller **82** and the user vehicle **12** whether communicating wirelessly as is initially the case or, following coupling, communicating via a direct data link.

[**0049**] After initial identification of the vehicle **12**, communication is provided to direct the vehicle **12** to a specific stall as shown in **FIG. 5**, or to inform the vehicle of available stalls as shown in **FIG. 8**. Each such stall is provided with a service port, for example a wheel stop service port **16**. As the vehicle **12** approaches the wheel stop service port, signals emitted by the proximity detector **120** cause the proximity transponder **124** of the vehicle **12** to emit a reply signal. The proximity detector emits a radio frequency (RF) signal having a predetermined radiation pattern shaped to facilitate proper positioning of the vehicle. The proximity transponder **124** of vehicle **12** is responsive to the signal and replies with a return message that, in its simplest form, merely alerts the proximity detector to the presence of vehicle **12** within the radiation pattern of the proximity detector **120**. Additional information may also be provided by the return message, such as a unique identification number for the vehicle **12**. In the present example, the unique identification number is compared with the identification provided via the wireless transponder **96**, as part of an authorization process performed by the coupling service **100**.

[**0050**] Referring to **FIG. 6** there is illustrated in a flow chart of the coupling service **100** in accordance with an embodiment of the present invention. A user vehicle approaches a station as represented by a process block **202**. As the node transceiver **88** sends out signals at regular intervals, a user vehicle **12** equipped with a transponder **96** sends a reply, or if equipped with a transceiver, detects the node transceiver signal and responds With a message as represented by a process block **204**. In response to the message from the user vehicle **12**, the access controller **85** initiates communication with the user vehicle **12**, as represented by a process block **206**. The access controller **85** uses the identification information of the message from the user vehicle **12** to identify the vehicle; and the coupling service **100** assigns a service port **16** for the vehicle **12** to dock with as represented by a process block **208**. At this point, the coupling service **100** assumes control, with the access controller **85** continuing to monitor communication between the user vehicle **12** and the coupling service **100**. The coupling service **100** relies upon the proximity detector **120** to query the position of the user vehicle **12** as represented by a decision block **210**. When not in position for docking, for example no reply message is received by the proximity detector **120**, feedback is provided to the vehicle **12** to correct the vehicle position, as represented by a process block **212**. The form of the feedback can be either instructions to the driver for manual positioning, or instructions to the user vehicle **12** for automated positioning. Once the user vehicle **12** is correctly positioned and parked, confirmation of the vehicle identification is provided based upon the unique identification number received in the reply message from the vehicle's proximity transponder **124**, as represented by a process block **214**. When confirmed, the coupling service **100** controls the movement of the connectivity device **18** of the user vehicle **12**, as represented by a process block **216**. Sensors in the wheel stop service port **16** provide feedback to the coupling service **100** allowing it to determine whether physical connection has been effected as represented by a decision block **218**. The physical connection includes proper positioning and physical securing of the port and vehicle such as a controlled clamping system (not shown). If yes, other services can then proceed as represented by a process block **220**. Such services can include fueling service **102**, security service **104**, as well as other services **106**, **108**. If physical connection has not been effected, corrective action is taken, as represented by a process block **220**.

[**0051**] An alternative process to the station selection of the user port, is one in which the user vehicle selects an unused service port to approach for service coupling, and the access controller uses the identification information of the message to track the user position and determine when it can be pre-associated with the user selected port. Then, the coupling service **100** assumes control, with the access controller **85** continuing to monitor communication between the user vehicle **12** and the coupling service **100**. Once the proximity detector **120** senses the user vehicle **12** is correctly positioned and parked, and verifies the vehicle identity **214**, the coupling service **100** controls the movement of the connectivity device **18** of the user vehicle **12**, as represented by a process block **216**. Sensors in the wheel stop service port **16** provide feedback to the coupling service **100** allowing it to determine whether physical connection has been effected as represented by a decision block **218**. The physical connection includes both proper positioning and physical securing of the port and vehicle such as a clamping system (not shown) controlled by the coupling service **100**. If yes, other services can then proceed as represented by a process block **220**. Such services can include fueling service **102**, security service **104**, as well as other services **106**, **108**. If physical connection has not been effected, corrective action is taken, as represented by a process block **220**, and can include port and vehicle status and diagnostic tests.

[**0052**] If the identity of the vehicle **12** is not confirmed at the decision block **214**, corrective action is taken as represented by the process block **220**. Such corrective action may be dependent upon a user profile for the vehicle corresponding to the unique identification number or it may follow a default procedure. In either case security procedures are invoked that may physically secure the vehicle or disable the vehicle until identity issues are resolved. All of these procedures are provided by the security service **104**.

[**0053**] The user vehicle **12** may be equipped with other communications devices (not shown) that can be used in concert with the wireless communications at appropriate times during the process described with regard to **FIG. 6**. For example, the proximity transponder **124** of user vehicle **12** may include a radio frequency identification device (RFID) that uses a separate RF channel from that used by the wireless LAN to communicate with the proximity detector to send identification messages including the unique identification number discussed herein above. The user vehicle **12** may also be equipped with a data communications device (not shown) coupled to the connectivity device **18** for exchanging data while physically coupled via link **126**to the energy exchange service port **16**. These additional communication devices may be used to monitor the vehicle presence near the port, for example the proximity detector **120**, or as a communication path **124** to allow the vehicle controller **30** to provide preferences or instructions to the access controller **85**. These additional communications devices are connected to the access controllers in a similar configuration as the node transceivers.

[**0054**] The energy exchange service port **16** may include sensors such as proximity devices **120** to sense the presence of a user vehicle **12** in a service stall (not shown) or near the energy exchange service port. The sensor measurement may include a further unique identification code that may be transferred to the access controller **85** as an input to any of the services **100, 102, 104, 106, 108**.

[**0055**] The purpose of the access controller **85** is to allow access to the energy exchange network resources provided by the service node controller **82**. The services within the service node controller **82** act as trusted applications that act as proxies for the users as represented by user vehicle **12**. It is the site services that are allowed access to the users, rather than the users that are allowed access to the site services.

[**0056**] In operation, the access controller **85** controls all access allowing only the appropriate level of access to proceed uninhibited. At any moment only access to the services required to support a current state of the energy exchange transaction is allowed through. Hence, once physical connection between the connectivity device **18** of the user vehicle **12** and the wheel stop service port **16** has been effected, the access controller **85** passes control to another associated service via the state machine **110**.

[**0057**] Once all authorized services operated by the access controller are terminated, the access controller concludes the physical service connection as represented by step **224**, including releasing the vehicle and port, such that the vehicle is free to start-up and drive from the port vicinity. The wireless connection/port is maintained with the vehicle until the vehicle is outside of communication range. The vehicle, while within range can re-dock to another port or request additional services through the LAN connection.

[**0058**] Referring to **FIG. 7**, there is illustrated a coupling method in accordance with an embodiment of the present invention. The method of **FIG. 7** is similar to that of **FIG. 6**, with the addition of vehicle position determination steps. The vehicle position determination is queried, as represented by a decision block **230**. When so determined, the access controller **85** provides guidance feedback to one of the port or vehicle controllers **34, 30** to guide the user vehicle **12** to a selected port as represented by a process block **232**. When the vehicle position has not been determined, an initial location routine is run, as represented by a process block **234**. The vehicle position determination is once again queried, as represented by a decision block **236** and if the user vehicle **12** is found to be correctly positioned, the process returns to the block **232**.

[**0059**] This is followed by confirming the identification of the vehicle as represented by a block **238** and controlling deployment of the connectivity device **18** to effect coupling as represented by a process block **240**. The process then passes to the process block **220** of **FIG. 6**. If the vehicle **12** is still not in position after the process block **236**, corrective-action is taken as represented by a process block **242**.

[**0060**] The access controller **85** provides guidance feedback to one of the port or vehicle controllers **34, 30** to guide the user vehicle **12** to a selected port, as represented by a process block **240**. Alternatively, the user vehicle can steer towards any available service port and the coupling service can wait until a proximity detector **120** for the user selected service port senses the presence of a vehicle, the confirm vehicle identification step **238** can then be used to identify the vehicle with the user selected port.

[**0061**] When the user vehicle **12** is sensed by the proximity detector **120** to be in coupling range position, a signal is provided back to the coupling service **100** via link **126** to the access controller **85** as represented by process block **234** and the vehicle identity is confirmed at a block **238**, the physical coupling is initiated as represented by process block **2240**.

[**0062**] Referring to **FIG. 8**, there is illustrated in a block diagram a coupling system in accordance with an embodiment of the present invention implemented with a multi-stall station. The station includes a station node controller **92** and a plurality of service terminals **14***a* through **14***h*. The station also includes a first wireless transceiver **90***a* for establishing a first wireless LAN within a first zone **250** encompassing the entire station and a second wireless transceiver **90***b* for establishing a second wireless LAN within a second zone **260** encompassing a portion of the station, thus requiring further wireless transceivers (not shown) if full coverage is desired. The first and second wireless LANs can be organized hierarchically with hand-offs from one to the other as appropriate, they can both operate to provide different services or they can cooperate to handle different portions of the services provided. The plurality of service terminals each includes a third wireless transceiver housed in the proximity detectors **120***a* through **120***h* for establishing a plurality of third wireless zones **270**.

[**0063**] The operation of the coupling system, in the context of the multi-stall station of **FIG. 8** is described with reference to vehicles **12** in various positions, for the present example, as though there represent a single vehicle approaching the station, for ease of description. However it should be appreciated that the coupling system is also capable of handling a plurality of vehicles in a plurality of positions as shown in **FIG. 8**.

[**0064**] In operation, a vehicle **12** approaches the station from a position outside the first zone **250**, as represented by a vehicle **12***a*. As the vehicle continues to approach the station, for example heading toward a vacant service terminal **14***b*, the vehicle enters the zone **250** and a first level of communication is established by the coupling service between the station node controller **92** and the vehicle **12***b* using the communications provided by the first wireless transceiver **90***a*. At this point either the coupling system directs the vehicle to an available service terminal **14** or the user vehicle selects a service terminal. For the present example, the former will be described. The vehicle is directed to service terminal **14***f* and as the vehicle approaches as represented by a vehicle **12***d*, the vehicle enters the second zone **260**, thereby effecting communication with the second wireless transceiver in the second wireless LAN. When the second wireless LAN is used for other services, the coupling service continues to communicate via the first wireless LAN. If first and second LANs are organized hierarchically, such that the first LAN dealt with station-wide communications and the second LAN dealt with communications for a smaller group of service terminals, the coupling service would provide a handoff from the first to the second LAN, then continue communicating via the second LAN. Alternatively the LANs could cooperate, so that different functions within a service were handled by different LANs.

[0065] Whichever LAN is currently responsible for communications then provides the vehicle **12***d* with instructions on how to dock the vehicle, service menus and promotional information. So that the vehicle can be brought into a position within the third zone **270** proximate to the desired service terminal, as represented by a vehicle **12***c* and service terminal **14***f*. Once within the third wireless zone **270**, a short-range transceiver within the proximity detector **120***f* listens for a response from the corresponding vehicle transponder **124***e* of vehicle **12***e*. From signal strength thresholds, angle of arrival and other signal characteristics, the proximity detector makes a determination whether the vehicle is in position for physical coupling. When the vehicle is insufficiently close, feedback is provided either to the driver in the case of manual docking or to the vehicle controller **30** for automated docking, or to both for semi-automated systems.

[0066] The proximity detector may also provide an additional level of vehicle identification by passing the vehicle identification number, provided by the proximity transponder **124***c* of vehicle **12***e* in a reply message.

[0067] Once sufficiently proximate to effect physical coupling as represented by a vehicle **12***c*, the coupling service initiates deployment of the connectivity device **18** as described herein above. When physical contact is confirmed via sensors in the receptacle **60**, the plug **70** of connectivity device **18** is clamped in position. Clamping is necessary to insure fluid communication with the service port **14***c*, as well as electrical power and data communications connections.

[0068] Prior to offering services to the vehicle **12***c*, further authentication steps may be performed by the security service **104** such as user identification through known techniques, for example password, personal identification number (PIN) or biometrics. The security service compares inputs received to user profile data registered for the vehicle and/or user.

[0069] Referring to **FIG. 9**, there is illustrated in a block diagram a coupling system in accordance with an embodiment of the present invention implemented with a two-stall residential configuration. The residential configuration includes a home node controller **92** and a pair of service terminals **14***j* and **14***k*, each having a wireless transceiver **90***j* and **90***k* and a proximity detector **120***j* and **120***k*. The wireless transceivers **90***j* and **90***k* have a limited range, so that their respective zones **260***j* and **260***k* do not overlap where a vehicle enters their respective stall or parking space.

[0070] Operation is similar to the station of **FIG. 8**, put requires a less complex configuration due to having only two stalls.

[0071] In operation, a vehicle user first decides in which space to park as represented by a vehicle **12***f* The vehicle then approaches the selected space, as represented by a vehicle **12***g* and in doing so enters zone **260***j* of the wireless transceiver **90***j*. The vehicle is then allowed to communicate as described above. The main difference here is that each service port **14** has its own transceiver, so no handoff or selection of service terminals is required, by the coupling service. The remaining coupling sequence is as described herein above.

[0072] Numerous modifications, variations and adaptations may be made to the particular embodiments of the invention described above without departing from the scope of the invention, which is defined in the claims.

What is claimed is:

1. Apparatus for coupling a vehicle to an energy exchange network comprising:

a service node controller including a coupling service and another service;

an access controller coupled to the service node controller for limiting access to service initiated access;

a first wireless transceiver coupled to the service node controller for establishing a wireless communications channel with a vehicle within a first zone;

a second wireless transceiver coupled to the access controller for establishing a proximity detection channel with the vehicle within a second zone itself within the first zone; and

a service port for physically coupling to the vehicle and coupled to the access controller.

2. Apparatus as claimed in claim 1 wherein the coupling service includes a vehicle identification module.

3 Apparatus as claimed in claim 2 wherein the vehicle identification module includes a first vehicle identification component for identifying a vehicle in the first zone.

4. Apparatus as claimed in claim 3 wherein the vehicle identification module includes a second vehicle identification component for identifying a vehicle in the second zone.

5. Apparatus as claimed in claim 4 wherein the second vehicle identification component is responsive to an identification message received by the second wireless transceiver.

6. Apparatus as claimed in claim 5 wherein the identification message includes a unique vehicle identification number.

7. Apparatus as claimed in claim 1 wherein the coupling service includes a service coupling clamping module for controlling physically clamping and releasing of the service port.

8. Apparatus as claimed in claim 7 wherein another service included in the service node controller is a security service.

9. Apparatus as claimed in claim 8 wherein the security service includes a module for disabling releasing of the service port.

10. Apparatus as claimed in claim 9 wherein the module for disabling is dependent upon vehicle identification.

11. Apparatus as claimed in claim 10 wherein the module for disabling is dependent upon a user profile associated with vehicle identification.

12. Apparatus as claimed in claim 1 wherein another service includes a fueling service.

13. A station for coupling vehicles to an energy exchange network comprising:

a station node controller for communicating with an energy exchange network;

a service node controller including a coupling service and another service;

an access controller coupled to the service node controller for limiting access to service initiated access;

a first wireless transceiver coupled to the service node controller for establishing a wireless communications channel with a vehicle within a first zone; and

a plurality of service terminals, each service terminals comprising:

a second wireless transceiver coupled to the access controller for establishing a proximity detection channel with the vehicle within a second zone; and

a service port for physically coupling to the vehicle and coupled to the access controller.

14. A residential arrangement for coupling vehicles to an energy exchange network comprising:

a service node controller for communicating with an energy exchange network and including a coupling service and another service;

an access controller coupled to the service node controller for limiting access to service initiated access; and

a service port for servicing a vehicle within a parking stall having a first wireless transceiver coupled to the access controller for establishing a wireless communications channel with the vehicle within a first zone within the parking stall;

a second wireless transceiver coupled to the access controller for establishing a proximity detection channel with the vehicle within a second zone itself within the first zone; and

a service port coupled to the access controller for physically coupling to the vehicle.

15. A method of coupling a vehicle to an energy exchange network the method comprising the steps of:

initiating communication with a vehicle in a first zone;

identifying the vehicle from the communication;

detecting the vehicle in a second zone;

providing feedback to cause the vehicle to be positioned appropriately for coupling; and

effecting physical coupling to the vehicle.

16. A method as claimed in claim 15 wherein the step of initiating communication includes the step of transmitting a first wireless signal to the vehicle.

17. A method as claimed in claim 16 wherein the step of initiating communication includes the step of the vehicle responding to the first wireless signal by sending a message in a reply signal.

18. A method as claimed in claim 17 wherein the step of identifying the vehicle includes the steps of receiving the reply signal, retrieving the message and comparing a first identifier contained therein with a list of vehicle identifiers.

19. A method as claimed in claim 18 wherein the step of detecting the vehicle in a second zone includes receiving a reply signal having a second identifier.

20. A method as claimed in claim 19 including the step of confirming vehicle identity by comparing first and second identifiers.

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